United States Patent [19]

Lang

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[54] **SEMISUBMERGED SHIP WITH HULL EXTENSIONS**

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[73] Assignee: **The United States of America as represented by the Secretary of the Navy,** Washington, D.C.

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[52] **U.S. Cl.** ..... **114/61,** 114/49, 114/.5 F

[51] **Int. Cl.** **B63b 1/32**

[58] **Field of Search** ..... 114/49, 52, 53, 54, 61, 114/123, 16 E, .5 F, .5 R; 9/1 R, 6

[56] **References Cited**

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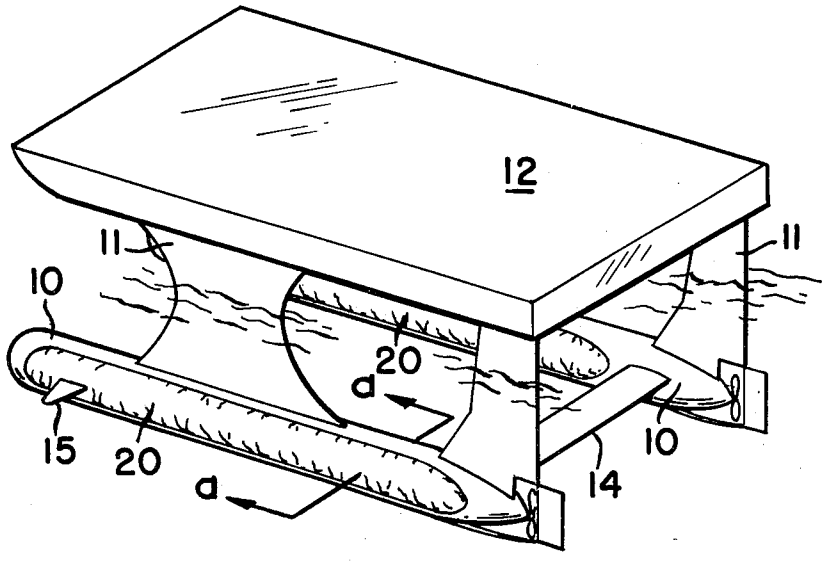
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[57] **ABSTRACT**

An improvement for the semisubmerged ship provides hull extensions for additional buoyancy or increased cargo and fuel storage which do not appreciably create more drag. In one configuration sacks disposed below the level of surface wave action are inflated to permit shallow water operation. Preferably, however, the hull extensions have a meniscoidal cross-sectional configuration and are mounted on the submerged hulls. Particularly in the case of the meniscoidal-shaped extensions, the structural integrity of the semisubmerged ship is not compromised and the ship's capability for high-speed operation remains substantially unimpaired since the hull extensions do not appreciably create excessive drag. Whatever configuration is chosen, the hull extensions are either permanently or releasably coupled to the hulls to allow flexibility in range and payload.

3 Claims, 13 Drawing Figures



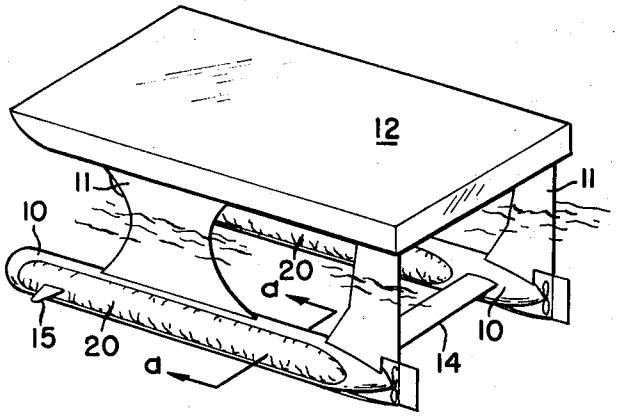


FIG.1

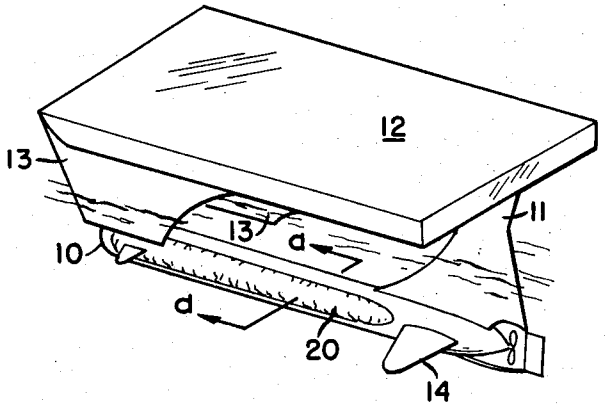


FIG.2

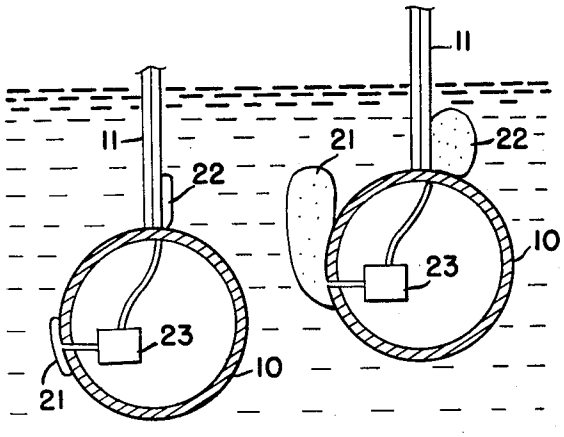


FIG.3a

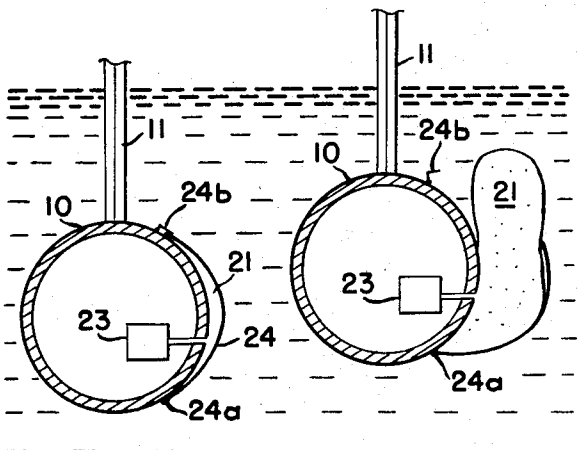


FIG.3b

FIG.4a FIG.4b

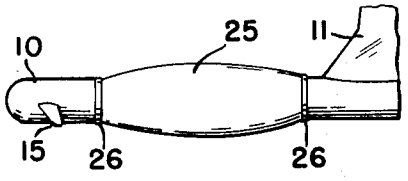


FIG.5

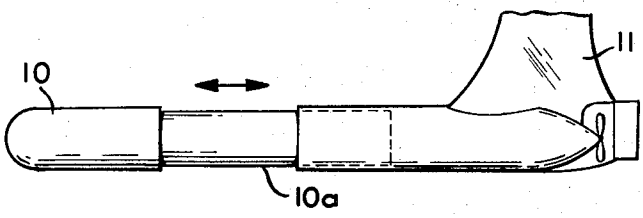


FIG. 6

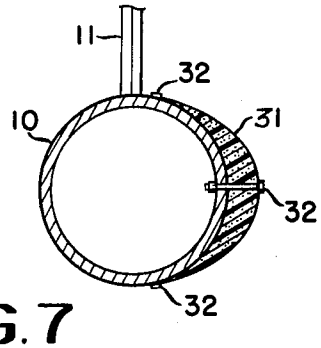


FIG. 7

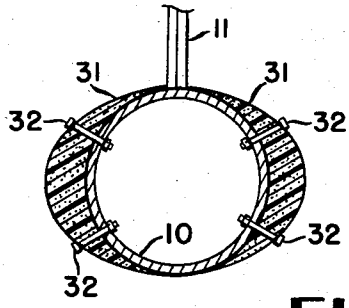


FIG. 8

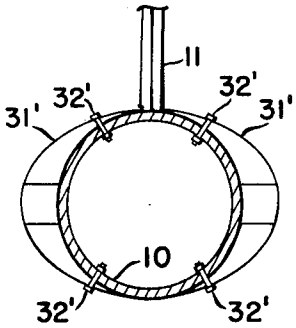


FIG. 9

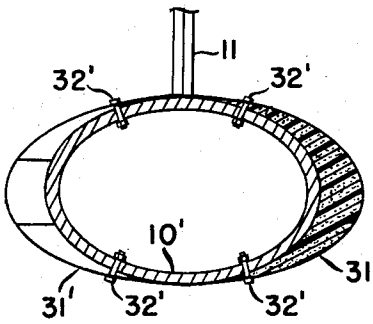


FIG. 10

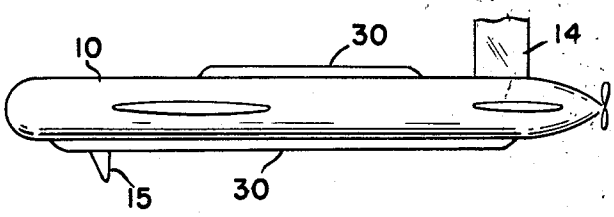


FIG. 11

SEMISUBMERGED SHIP WITH HULL EXTENSIONS

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

The semisubmerged ship for which this invention is an unobvious improvement, is thoroughly described in U.S. Pat. No. 3,623,444. Briefly, the semisubmerged ship places one or two hulls well below the area of surface wave action and supports a platform above the water by at least one water surface piercing strut member. Horizonally oriented stabilizers, vanes and canard fins are mounted on the hulls to ensure high-speed dynamic pitch, roll, and heave stability. However, one limitation of the semisubmerged ship became apparent in that the maximum buoying force was a fixed function governed by the dimensions of its submerged hulls. Thus, its maximum range was limited by the amount of fuel that could be carried and its maximum payload was similarly restricted. One obvious solution would be to build a semisubmerged ship with larger hulls. On short-range routine operations the larger hulled ship would be inefficient when compared to a ship having smaller hulls specifically designed for short-range or reduced-payload applications. Therefore, in semisubmerged ship design a need for an increased buoyancy and payload while not apprciably increasing the drag continues to exist. Structure and devices to increase the buoyancy of a surface craft or to reduce its drag are many and varied in design. For instance, U.S. Pat. No. 6469 issued to Abraham Lincoln in 1849 directly addressed itself to reduce the draft of steamboats. Expandable chambers were connected to the sides of the steamboat to buoy it over shoals. The expandable chambers were placed in the area of surface wave action to greatly increase the ship's drag and hence render such a modification unsuitable for the high speed semisubmerged ship. While this approach may represent a noteworthy modification for surface ships, taken in light of the state of technology at the time, history has proven that the inventor could and did better devote his talents to other fields of endeavor. Two other more recent attempts to reduce a ship's draft are shown in two U.S. Patents to Livas. These U.S. Pats., No. 3,171,377 and 3,198,157 show the use of an inflatable flexible membrane or the attachment of buoyant chambers to the side of the hull. Either approach mounts the buoyancy elements in the area of surface wave action and turbulance and seriously effects the ship's manueverability and drag. Others have tried securing pontoons onto the sides of a ship's hull to reduce draft. Here again, the buoying members are located on the surface of the water and by being so located impose intolerable speed and manueverability limitations.

SUMMARY OF THE INVENTION

The present invention is directed to providing an improvement for a semisubmerged ship having at least one hull disposed beneath the water's surface, a platform carried above the water's surface, and at least one water-surface piercing strut member interconnecting the hull and platform. A means for increasing the volume displaced by the semisubmerged ship is located well beneath the area of surface wave action and is secured in place by a mounting means which ensures increased displacement while not introducing excessive drag.

It is a prime object of the invention to provide an improvement for the semisubmerged ship.

Another object is to provide for increasing the payload and range of the semisubmerged ship.

Still another object is to provide for hull extensions carried below the area of surface wave action to ensure greater payload.

Still another object is to provide hull extensions configured for increasing the semisubmerged ship's buoyancy while not overly compromising drag.

Still another object is to provide an improvement for the semisubmerged ship giving the ship a reduced draft.

Yet another object of the invention is to provide for hull extensions which simultaneously provide increased buoyancy, increased range, and increased protection for the semisubmerged ship.

These and other objects of the invention will become more readily apparent from the ensuing specification when taken with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1** and **2** are isometric depictions of two typical examples of the semisubmerged ship showing the hull extensions in place.

FIGS. **3***a* and **3***b* schematically in cross-section show one embodiment of the invention taken generally along lines *a–a* in FIGS. **1** and **2.**

FIGS. **4***a* and **4***b* schematically in cross-section show another embodiment of the invention.

FIG. **5** shows still another embodiment of the invention.

FIG. **6** shows yet another embodiment of the invention.

FIGS. **7, 8, 9,** and **10** show the preferred configuration of the invention.

FIG. **11** shows typical mounting positions of the hull extensions.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. **1** and **2** of the drawings, the semisubmerged ship is depicted in two typical embodiments each having one or more hulls **10** disposed one or more hull diameters below the surface of the body of water. At least one water-surface piercing strut **11** extends upward from a hull to support a platform **12** above the water's surface and, in the embodiment of FIG. **2,** a pair of water-surface piercing strut members **13** depend from opposite lateral extremes of the platform into the water.

Horizontally oriented stabilizers **14** having a rectangular configuration in FIG. **1,** or a delta configuration in FIG. **2,** and canard fins **15** are mounted on the hulls a distance below the area of surface wave turbulance. The struts, horizontally oriented stabilizers, and canard fins hydrodynamically cooperate as the semisubmerged ship makes a high speed run to ensure the vessel's stability in dynamic pitch, roll and heave. These two representative examples possess superior dynamic and static stability. Suitable control and drive mechanisms suitably articulate the canard fins and stabilizers and

additional flaps, vents etc. optionally are included to ensure such stability.

Inclusion of the hull extensions **20** has resulted in these designs having a significantly increased payload and range without adding excessive drag or impairing the vessel's manueverability.

Increased buoyancy is provided for by the hull extensions which may be one of a variety of configurations. Irrespective of which configuration is chosen, it is important to place the extensions well below the water's surface. Laboratory tests have indicated that such placement reduces the problems associated with surface wave action e.g., excessive drag and imparied maneuverability.

One embodiment of the hull extensions is shown in FIGS. 3*a* and 3*b*. An inflatable sack **21** is carried on a submerged hull while another inflatable sack **22** is mounted on a strut. Both the sacks are located well below the area of surface wave action and do not introduce the problems attendant surface wave interaction. The sacks are fashioned from a heavy, flexible material such as rubber impregnated canvas or a heavy duty plastic sheet. In any event the sacks are selectively inflatable by a source of pressurized gas **23** interconnected by conventional piping to inflate the sacks when an increased buoying capability is called for. The flexible sacks are bonded or otherwise suitably secured onto discrete portions of the hull and the struts may be tailored to run the entire length of the hull depending on the degree of buoyancy wanted. High speed operation is somewhat impaired because of the sack's flexibility. Another drawback of using flexible sacks is that they are constantly exposed to external damage especially when the semisubmerged ship is operating near docks and piers. Damage from routine abuse also tends to shorten the sacks's useful life.

One attempt at reducing the flexible, inflatable sack's vulnerability to damage is shown in the embodiment of FIGS. 4*a* and 4*b*. Here, a source of gas **23** is connected to a flexible, inflatable sack **21** of the type referred to above and which is carried inside a curved cover plate **24** joined to the hull by a hinge **24***a* and a latch **24***b*. When occasional buoyancy is needed, for example, when the semisubmerged ship is entering a shallow harbor, or passing over a reef, gas from source **23** is vented to inflatable sack **21** after latch **24***b* has been released. Cover plate **24** is rotated in a clockwise direction about hinge **24***a* as the sack fills with gas. In this embodiment it has been found expedient to secure the sack to the inner surface of the hinged cover plate so that when the sack is inflated the cover plate is automatically rotated to release the sack, and later, when the sack is evacuated, it pulls cover plate **24** back against hull **10** to be securely engaged by latch **24***b*.

Another modification employing a flexible flotation member is shown in FIG. **5.** An elongate resilient sleeve **25** is gripped at opposite ends by large ring-like clamp members **26.** A source of pressurized gas, not shown in FIG. **5,** is selectively vented to the interior of resilient sleeve to produce the desired degree of supplemental buoyancy.

The use of flexible sacks or sleeves is not entirely satisfactory for high speed operation. The high water-flow rate over the flexible surfaces causes fluctuation and other flow related consequences.

In addition the flexible devices are vulnerable to puncture and tearing.

An alternate mode of construction of the embodiment of FIG. **5** calls for substituting a rigid torose-shaped sleeve **25** in place of an inflatable resilient sleeve **25.** Mounting a rigid sleeve does avoid the flexible sleeve problems yet it introduces some of its own, particularly when the sleeve is mounted on the external surface of hull **10.** If the sleeve is an integral unit, canard fin **15** would have to be disassembled during installation and removal. If the rigid sleeve is separated into longitudinal sections an improved design, discussed below, would better serve the anticipated needs.

Another modification for giving a semisubmerged ship a variable buoyancy capability is shown in FIG. **6.** A telescoping section **10***a* of hull **10** is concentrically extended by an internally carried rack and pinion mechanism, not shown for the sake of simplicity in the drawings. Suitable seals are included to prevent the flooding of the hulls and pressurized gas is vented to the interior of the extended hull to reduce the possibility of flooding.

The preferred embodiments for providing the increased buoyancy capability are shown in the variety of hull extensions schematically depicted in FIGS. **7** through **10.** These hull extensions optionally extend part-way or all-the-way on opposite lateral sides or on only one side of a hull, see hull extensions **30** in FIG. **11.** In the embodiment of FIG. **7** a single solid extension **31** is shaped in a meniscoidal configuration with an inner surface fitting around the circular hull **10** and with an outer surface shaped to hydrodynamically cooperate with the surrounding water.

In this embodiment the hull extension is a rigid material having a density less than water to provide a buoying force. Wood, polyeurthane foam, and other equivalent materials may be used. In this regard a material which affords a degree of protection from underwater ordnance or submerged obstacles would be the best choice.

The meniscoidal hull extension is releasably connected by a plurality of bolts **32** or any other suitable connecting means. Using bolts or an equivalent releasable connector, gives a semisubmerged ship an immediate variable buoyancy capability. If a task calls for a greater payload, then meniscoidal hull extensions having a larger cross-sectional configuration are mounted on the hull. Considerable mission flexibility is assured by having several sets of hull extensions on hand. None of the herein described extensions compromises the ship's structural integrity yet all give added buoyancy and protection for the hulls.

The meniscoidal shaped extension, while greatly increasing the hull's buoyancy does not create an excessive amount of drag or impair the vessel's maneuverability. Experimental test data indicates that the drag coefficient does not change appreciably with the increased buoying capability. That is to say, by example, the drag was increased no more than 10 percent with a 30 percent increase in displacement.

The embodiment of FIG. **8** includes two rigid meniscoidal hull extensions **31** also secured in place by bolts **32** or equivalent means. The two hull extensions create more buoying force and present a symetrical hull which reduces control and trim problems, particularly in the single hull semisubmerged ship.

The embodiment of FIG. **9** has essentially the same cross-sectional configuration as the embodiment of

FIG. **8** but meniscoidal hull extensions **31** are **31'** are hollow and are compartmented to allow for the storage of fuel, supplies, ordnance or to function as buoyancy chambers depending on what is needed. Here again, the hull sections are releasably coupled to the hulls by bolts **32'** to give the ship a variable buoyancy.

The embodiment of FIG. **10** shows a combination of a rigid meniscoidal extension **31** and a compartmented meniscoidal extension **31'** carried on an elliptical hull **10'**. When a twin hull semisubmerged ship is so modified, the rigid hull extension is placed on the outside to further protect the hull while providing buoyancy.

Particularly with respect to the embodiments of FIGS. **7, 8, 9** and **10** data has demonstrated that for a given increase in buoyancy the drag does not appreciably increase. The semisubmerged ship's structural integrity remains, it not sacrificed irrespective that the ship's range and payload have been greatly increased.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings, and, it is therefore understood that within the scope of the disclosed inventive concept, the invention may be practiced otherwise then specifically described.

What is claimed is:

1. In a semisubmerged ship having at least one hull disposed beneath the water's surface, a platform carried above the water's surface, and at least one water-surface piercing strut member, interconnecting the hull and platform, an improvement therefor is provided comprising:

a pair of means for increasing the volume displaced by said semisubmerged ship each disposed on opposite sides of said hull and having a rigid meniscoidal cross-sectional configuration with its inner contour shaped to accommodate said hull and its outer contour shaped to reduce the problems associated with drag, a first one of the increasing means has at least one compartment for buoyancy and storage and a second one of the increasing means is filled with a rigid buoying material for buoyancy and protection of the hull and both of the increasing means cooperate to give the composite structure created thereby an elliptical cross-sectional appearance, and;

means for removeably mounting both increasing means beneath the water's surface on said hull to give said semisubmerged ship a variable displacement.

2. An improvement according to claim **1** in which at least one of the increasing means extends nearly the full length of said hull for providing increased buoyancy and protection thereto.

3. An improvement according to claim **1** in which at least one of the increasing means extends only a fraction of the length of said hull.

* * * * *